Requirements for Minor Subdivision of GCDB Parcels:

Purpose of Document

This document provides requirements for writing a software application to automate the further division of 40 acre parcels within the GCDB data, based on stored land descriptions existing in the LR2000 data bases. The result of these subdivisions will be the core instructions for the continued reconstruction of minor subdivision parcels during each cycle of maintenance of the surveyed data.

Table of Contents

1. Background:

<u>Need for Minor Subdivision Explained:</u> The land records of the BLM contain units of land that are administered as aliquot pieces below the 40 acre parcel level. These divisions below the 40 acre parcel level are known as "minor subdivision".   Digital records in the LR2000 databases such as Case Recordation and Land Status contain full legal descriptions of known parcels well below the 40-acre level. The Legal Land Description (LLD) system adopted a data format that could only describe land to the 40-acre level. The attributes for legal land descriptions have been assigned to GCDB parcels, employing the LLD format, even though the GCDB software is capable of creating and <u>displaying</u> land boundaries to any level of detail. However, because the labeling (attribution) has been based on the LLD format, GCDB currently contains only <u>labels</u> polygons with a location at the 40-acre level. These historic limitations of GCDB attribution can be eliminated if GCDB extends its data structure to incorporate aliquot part descriptions to a much more granular level, as defined in the proposed GCDB .GLD file. Because many of the minor subdivision parcels have never been produced spatially, an automatic process will need to be devised, which creates aliquot parts to a detail necessary to display those legal land descriptions found in the LR 2000 data bases.   The geometric processes needed to accomplish this division would then be stored for later use when performing future maintenance and updates.

<u>Synopsis of Needed Functions:</u> An application for performing minor subdivision needs to be written which will read LR2000 land records, on a township-by-township basis and extract the description of each minor subdivision parcel. A report will then be created to store this data into a specific file format. The functionality of this extraction process is described in Section 2, below. Using the description of each minor subdivision parcel as a guide, the GCDB data as it exists must be interpreted to discern what further section subdivision needs to be performed. Any newly created points will need a unique GCDB point identifier indicating its function within the subdivision routine.   Any coordinate geometry instructions required to perform the more detailed subdivision must be written to a GCDB file (.ADD), which will then be used to reconstruct these minor subdivisions each time the dataset is being rebuilt during maintenance. Minor subdivision parcels must be described with a unique identifier, such as the N½ NW¼ SE¼ NW¼, of Section One, Township Eleven North, Range Ten West, New Mexico, including those parcels that have been previously divided spatially and not yet attributed to the needed detail. The functionality for modifying GCDB data files is described in Section 3, below.

<u>State of GCDB Data:</u> Some GCDB staffs have taken the time-consuming task of subdividing sections to the level shown on the Master Title Plats, even though these minor subdivision parcels could not be attributed to a level of detail lower than forty acres. Others subdivide only to the 40-acre level, anticipating that a minor subdivision function will become available which will ensure a direct link between GCDB and LR2000.

<u>Standards Developed to Implement Minor Subdivisions:</u> To accommodate minor subdivision, there are proposed extensions to the point ID naming conventions and nominal location codes currently employed by the GCDB staffs.

2. Converting Minor Subdivisions from LR2000 to GCDB's GLD File Format.

2.1 - Extraction of Minor Subdivisions from Case Recordation: The minor subdivision descriptions in the Case Recordation database must be extracted into a format usable to GCDB processes. The most useful format to report the minor subdivisions is the format employed proposed for the GLD file. Below is a one-line example taken from a .GLD attribute file, which is explained in further detail in Appendix B.

032   K*mmmm* **A**   **40.000 F**   **23T0320N0150W**   365620.4348 1082649.3781

The items in bold are those which would be extracted from Case Recordation. The underlined items represent the minor subdivision locations within this particular 40-acre parcel. The more detailed the subdivision, the more minor subdivision codes will be needed. In Appendix B., see footnote 2 under the GLD format table.

Example: A parcel is described in Case Recordation as: SESWSW in Sec01, SWSES2 in Sec01, NWNEE2 in Sec12, and NENWNW in Sec12, and NWNENWE2 in Sec 12.

Its entries in the GLD file would be reported respectively as follows:

```
001  OT        B  10.000 F       23T0320N0030E
001  LX        B  20.000 F       23T0320N0030E
012  EY        B  20.000 F       23T0320N0030E
012  BS        B  10.000 F       23T0320N0030E
012  ESY       B   5.000 F       23T0320N0030E
```
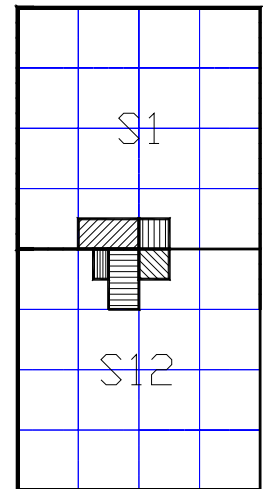
It would appear spatially as seen in Figure 2-1, at right.

Figure 2-1

2.2 - Extraction of minor subdivisions from Status.   In the Status database, minor subdivisions are expressed as alpha characters (Xs) associated with a minor subdivision indicator. My research indicates that the Status data base tracks minor subdivisions and proper acreages, but has no mechanism to store an actual minor subdivision location, other than the nominal location at the 40-acre level. In light of this, it seems appropriate to use an inventory of minor subdivision entries in Status to crosscheck with equivalent entries in Case Recordation for the likely event where these two databases are not in synch. Only review of the paper records will confirm what caused the discrepancy, and this comparison will provide a useful structure for the workload to resolve these problems.

A report of the discrepancies between Case Recordation and Status should be generated if there are discrepancies.

3. Division of the spatial elements of GCDB into minor subdivisions

3.0 After extracting a report of the descriptions of the known minor subdivisions within a given township it will be necessary to use this report to update the spatial representation of these parcels in GCDB. This will be performed on a township-by-township basis and there is a logical order to follow for the editing of each line in the GLD file, as the following steps outline:

Select a minor subdivision string from the .GLD file. 3.1
Find minor subdivisions by studying the point/line locations and point IDs. in .LX file……….. 3.2
Create any points and/or lines necessary to create each new level of minor subdivision 3.3

These steps will now be described in more detail. At this stage the point IDs of a 40-acre piece is determined by the nominal location code. These steps apply only to finishing the next level of minor subdivision, so steps 3.2 to 3.8 are iterative processes, which are performed until the entire set of minor subdivision codes, found on any particular line in the GLD file, are processed.

3.1)   Select a minor subdivision string from the GLD file.

The next unprocessed line of the GLD file is read and becomes the current line. The locational information from columns 1-10 of the current line is stored in memory.

3.2)   Find existing minor subdivision polygons by studying the point/line locations and point IDs.

Identify the polygon that encompasses the 40-acre nominal location parcels using the GCDB point ID scheme as a guide. After delineating a particular nominal parcel, save a list of all existing points and lines on or inside this polygon

3.3)   Create any points and lines necessary to create minor subdivision polygons.

Determine and save to memory a list of the necessary point IDs and lines that will be necessary to accomplish subdivision to the required level of detail.

Search existing points for needed corners by ID. If points are not found:

-   To divide a polygon in half. Calculate two midpoint coordinates along the opposing polygon sides according to midpoint instructions in Appendix C. Add a line connecting the two midpoints according to add-a-line instructions in Appendix C.

-   To divide a polygons into quarters. Calculate midpoint coordinates along all four sides of the aliquot parcel according to midpoint instructions in Appendix C. Create a "center" corner at intersection of the two lines connecting the midpoints according to midpoint instructions in Appendix C.

Appendix A - The GCDB Point ID naming convention

The GCDB ID has 6 characters formed by two pairs of 3 character values. Currently these values are entirely numeric. If the first three characters (prefix) of a point's ID are between 100 and 711 then those characters describe the point's position from West to East, within the township, and the rightmost three characters (suffix) describe the point's position, from North to South, within the township. If the first three characters are greater than 711 then the point is a special survey point, not applicable to subdivision, and is irrelevant to this discussion.

Each three-character part of the ID breaks down with very simple rules.

Point IDs for dividing a township into sections

Below is an example of a typical township with standard point Ids assigned to all section corners. The grid of seven North-South, and seven East-West lines has been constructed. The prefixes of the North-South lines begin with the number 100, on the western-most line, and increase in 100 unit increments as the lines proceed easterly, to the eastern-most line, which is identified by the prefix of 700.

The seven East-West lines begin with a suffix of 100, at the southern-most line in the township and increase in 100 unit increments, to the northern-most line, which is identified by a suffix of 700.

Figure A-1

Point IDs for dividing a section

S   The second character divides the section line into 8 portions of 10 chain distances, or down to the 1/64th corner level. The values are from 0-7, where 0 is on the section line and 7 is 10 chs from the next section line.
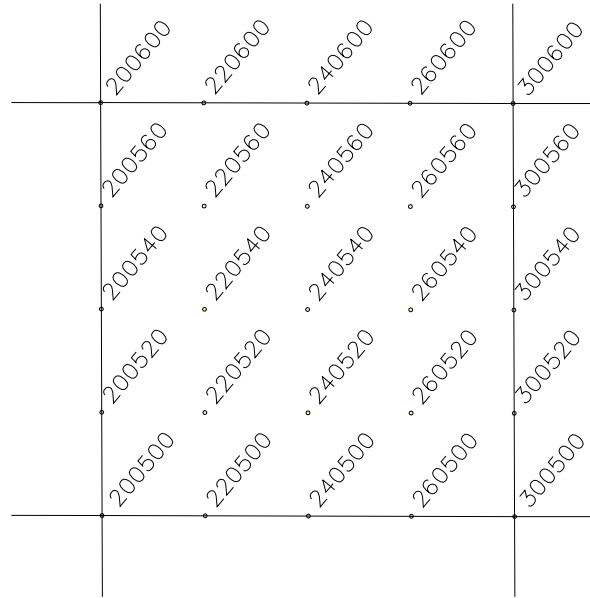
Figure A-2, GCDB IDs for Section 8

Point IDs for dividing a 40 acre aliquot piece.

S   The third character divides the 10-chain segment into further divisions. The value of 0, 1, 9, 2 or 8 indicates a 1/64th, 1/16th, 1/4 or section line. A value of 5 can indicate a 1/256th corner. Any other numbers can be used for further division. If there are not enough numbers, which could occur along "offset" lines, then arbitrary numbers can be used. Refer to Figures A-3 and A-4, below.

Figure A-3, GCDB ID scheme for Minor Subdivision

Area Map

Sec 3

Figure A-4, GCDB ID example for NW ¼ of SE ¼ of SW ¼ of Section 3.

```
aaabcdeeee fggggg hh iii jjjjj.jjj k l mnnn ooTpppppqqqqqr ssssss.ssss ttttttt.tttt u v
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345 67
         1         2         3         4         5         6         7         8
```

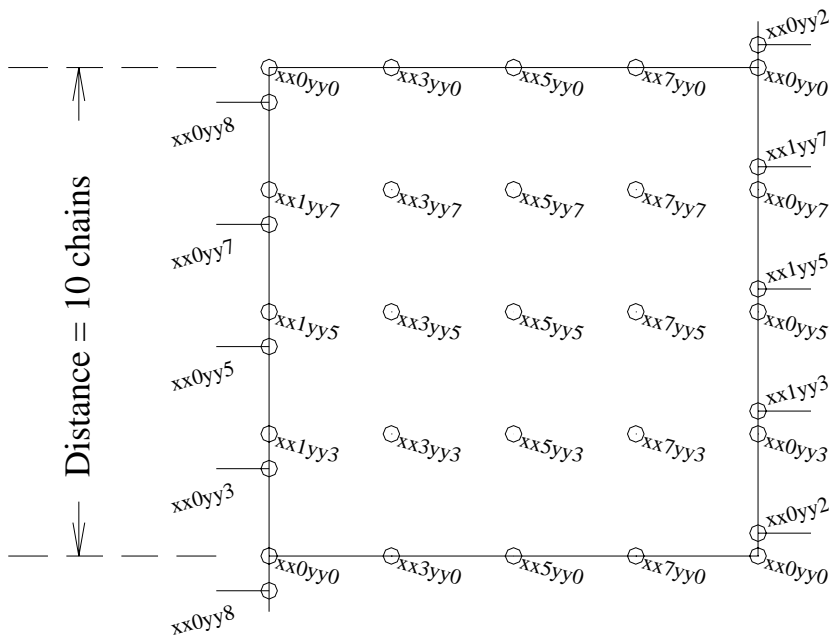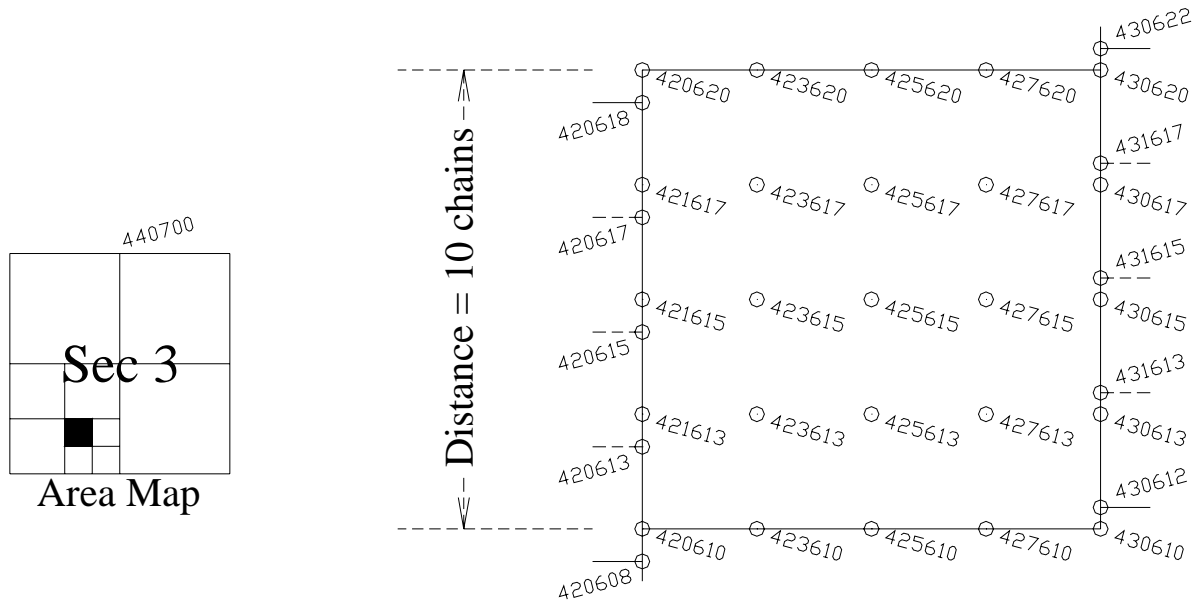```
                   Proposed GLD Format
         Cols.   Definition   Lower Case Code
         1-3 Section Number   aaa
         4   Section fractional code   b
         5   Section duplicate code or " " c
         6   Nominal Location¹   d
         7-10   Minor Subdivision Codes²   eeee
         11   A@
         12   Survey Type³   f
         13-17 Survey Number   ggggg
         18   A@
         19-20 Survey Suffix   hh
         21   A@
         22-24 Survey Notes   iii
         25   A@
         26-34 Acres from survey plat⁴   jjjjj.jjj
         35   A@
         36   Acreage Source Code⁵   k
         37   A@
         38   Duplicate Description Code   l
         39   A@
         40   Discrepancy Code   m
         41-43 Exception code(s)   nnn
         44   A@
         45-46 Meridian   oo
         47   AT@
         48-52 Tier Value   ppppp
         53-57 Range Value   qqqqq
         58   Township Duplicate Code   r
         59   A@
         60-70 Latitude, DDMMSS.ssss   s (6.4)
         71   A@
         72-83 Longitude, DDDMMSS.ssss   t (7.4)
         84   A@
         85   Subsurface Only Code   u

         86   A@

         87   LR2000 Validation Code   v
```

Cols. Definition — $\underline{\text{Lower Case Code}}$

- 1-3 Section Number — aaa
- 4 **Section fractional code** — b
- 5 **Section duplicate code or " "** — c
- 6 Nominal Location[1] — d
- 7-10 **Minor Subdivision Codes[2]** — eeee
- 11 A@
- 12 Survey Type[3] — f
- 13-17 Survey Number — ggggg
- 18 A@
- 19-20 Survey Suffix — hh
- 21 A@
- 22-24 **Survey Notes** — iii
- 25 A@
- 26-34 **Acres from survey plat[4]** — jjjjj.jjj
- 35 A@
- 36 **Acreage Source Code[5]** — k
- 37 A@
- 38 **Duplicate Description Code** — l
- 39 A@
- 40 **Discrepancy Code** — m
- 41-43 **Exception code(s)** — nnn
- 44 A@
- 45-46 **Meridian** — oo
- 47 AT@
- 48-52 **Tier Value** — ppppp
- 53-57 **Range Value** — qqqqq
- 58 **Township Duplicate Code** — r
- 59 A@
- 60-70 Latitude, DDMMSS.ssss — s (6.4)
- 71 A@
- 72-83 Longitude, DDDMMSS.ssss — t (7.4)
- 84 A@
- 85 **Subsurface Only Code** — u
- 86 A@
- 87 **LR2000 Validation Code** — v

[1]The **nominal location codes** describe land to the 40-acre parcel level with the mapping of these characters:

A = NE¼NE¼          B = NE¼NW¼          C = NE¼SW¼          D = NE¼SE¼
E = NW¼NE¼          F = NW¼NW¼          G = NW¼SW¼          H = NE¼SE¼
I = SW¼NE¼          J = SW¼NW¼          K = SW¼SW¼          L = SW¼SE¼
M = SE¼NE¼          N = SE¼NW¼          O = SE¼SW¼          P = SE¼SE¼

These descriptions are spoken or written in the reverse order as written in current data storage. For example, NE¼NW¼ is spoken or written verbally as "the Northwest quarter of the Northeast quarter".

The letter Q is defined to mean "an aggregation of aliquot parts" and does not apply to minor subdivisions.  The letter Z is defined to mean "not relevant - there is no PLSS here."

[2]The **minor subdivision codes** describe divisions below the 40-acre parcel level.  The A-P nominal location codes can be used here if they map properly, such as the NENWSWNW, which would have a nominal location code of B and a minor subdivision code of J.  If however the land isn't an even 2½-acre division, then other letters must be used to represent ½ and ¼ divisions. These codes are:

R = NE¼          S = NW¼          T = SW¼          U = SE¼
V = N½            W = W½            X = S½            Y = E½

To parse out each description, read left to right (right to left on verbal/spoken descriptions), as many pairs of ¼s and translate to the A-P codes, then append the ¼ or ½ codes as appropriate

Example: the S½ of the NW¼ of the NE¼ of the SE¼ would have a code of MSX and would have been stored in LR2000 as SENENWS2.

[3]Survey type will always be B for coding minor subdivision parcels.

[4]The acreage value assigned will be the area of the particular aliquot part involved, which will always be an even increment (i.e. 40, 20, 10, 5, 2.5 ). These aliquot part acreages are not based on the actual calculation of area that  uses the coordinate values of any given aliquot parcel.

[5]An Acreage Source Code is necessary to track the integrity of the acreage value. Codes:
        A = Calculated by query that added all LLD acreages by special survey
        B = Acreage is from official plat and agrees with LLD sum
        C = Acreage is from official plat and disagrees with LLD sum
        D = Acreage is approximated from MTP or other paper map
        E = Acreage is derived from GIS coverage or AutoCAD drawing.
        F = Acreage is assigned during minor subdivision.
        0 = Acreage is classic LLD value, not aggregated

The minor subdivision program will always populate this field with an F.

The data content discussed below pertains to data that the minor subdivision will write to the ADD file.  Other variances exist, but their content need not be understood by minor subdivision, just preserved.

```
 1 440670 440660 440700     .00000  1         .000         .000
 2 950105 500300 520300     .00000  2         .000         .000
 0      0 901030 901045     .00000  2         .000         .000
 3 170400 170410      0     .00000  0         .000         .000
...........................................................
12345678901234567890123456789012345678901234567890123456 7
         1         2         3         4         5
```

Column 02: Construction method.
  - "1" indicates midpoint/proportion/traverse. We are only concerned with midpoint calculations when producing minor subdivision parcels, not the proportion or traverse calculations.
  - "2" indicates the 1st of 2 lines needed to describe an intersection. This line describes the 1st line.
  - "0" indicates the 2nd of 2 lines needed to describe an intersection. This line describes the 2nd line.
  - "3" indicates add a line between two points. This will be used with minor sub codes V, W, X, Y.

Columns 04-09: Point ID of point being generated. A value of "0" means not applicable.

Columns 11-16: Point ID of controlling corner, at the beginning of the line. ("from")

Columns 18-23: Point ID of controlling corner, at the end of the line. ("to")

Columns 25-33: Not applicable to minor subdivision.

Column 36: Plane/Geodetic code:
  - "1" indicates computations were made using plane geometry (usually corners in section interior)
  - "2" indicates computations were made using geodetic geometry (usually on section boundaries)
  - "0" indicates no computations were made (used with method code 3 - "Add a line")

Columns 38-46: Not applicable to minor subdivision.

Columns 48-56: Not applicable to minor subdivision.

Note: Order of entries in the ADD file is irrelevant.

Appendix B, continued - The GMM .IID file format

existing "AN-style" format:
```
 ALIQUOT SW 1/4  OF THE NW 1/4 OF SECTION 22     39.5 ACRES
Sec_022 G T_A                 40.000; M05T0040NR0260W
 400340 400360 420360 420340 400340
 PARCEL N,E       242119.860      1473983.121
```

The above segment is a typical entry, or "paragraph" of an aliquot 40 acre parcel as indicated in the GCDB .AN file. This would be the building block for minor subdivisions, but there is no provision to store minor subdivision data within this format. The following example is the proposed IID format that solves that limitation.

proposed "GLD-style" format:
```
 ALIQUOT SW 1/4  OF THE NW 1/4 OF SECTION 22     39.5 ACRES
 an: Sec_022 G T_A                 40.000; M05T0040NR0260W
022  G     A                 40.000 F        05T0040N0260W
 400340 400360 420360 420340 400340
 PARCEL N,E       242119.860      1473983.121
```

- The 1st line is a verbose description followed by the acreage computed with GCDB coords.
- The 2nd line is " an:" plus a replica of data from the AN file, but without the centroid Lat/Long
- The 3rd line is a replica of data from the GLD file, but without the centroid Lat/Long
- The 4th line is a sequential listing of all GCDB point IDs that form the polygon
- The 5th line is the Y,X coordinates of the centroid, in state plane coordinate projection

Note that in polygons with multiple attributes, the old strategy was to create a new "paragraph" for each attribute. The existing strategy now allows one paragraph per polygon and the multiple attributes are listed on sequential lines. The current GCDB data is represented by both approaches to formatting.

other formatting to preserve, but not to write:
```
 WARNING - FOLLOWING IS IN OUTY BUT NO LOT FOUND FOR IT!!!!
 SPECIAL ESTIMATED IN
 ALIQUOT NE 1/4  OF THE NE 1/4 OF SECTION 36     25.8 ACRES
GLINK Edited: Sec_036 A T_? 0                  .000; M14T0030NR0160E
Sec_036 A T_U     01       370.000; M14T0030NR0160E
 STANDARD  MISCELLANEOUS  MEANDER  TRACT  MINERAL  INTERSECTION
   YES         YES          NO      NO      NO         YES
 700200 660200 660160 950104 711055 950100 700200
 PARCEL N,E       935728.276      895107.698
 POLYGON INSIDE LARGER OUTY PARCEL
 600100 600200 700200 950100 711055 711050 711045 950107 600100
```

Note: The first column in IID is reserved for lines with attribute data. Other lines are basically comment lines, but GMM standardizes critical statements with known keywords.

After the polygon entries (paragraphs) are listed, the IID file lists statistical data about the township.

Appendix C - Calculation of midpoints and intersections and add-a-line

There are three major geometric processes involved in creating minor subdivision parcels, they are: creating midpoints, creating intersection points and adding lines.

Midpoint: Midpoint is at mean distance "along the boundary", and not necessarily the average of the coordinates of the two polygon corners. There may be monumented points along the boundary that cause a break in bearing along the boundary.

S　　　If there is no intermediate point along the boundary, then use the arithmetic mean of the controlling coordinates. Example is E ¼ corner in Figure 3-1.

S　　　If there is an intermediate point or points along the boundary, first determine if there is a point at midpoint. (Solid clue: check RAW file. Compare the distances from the intermediate point out to the controlling corners - they should be the same. For example, in Figure C-1, if a = b + c, then the N¼ corner is at midpoint. If close, check for a midpoint on the opposite side of the polygon and if there is a line connecting these two points, then the intermediate point is at midpoint.)

S　　　　　If the point is at midpoint, then no calculation needs to be made. N ¼ in Fig. C-3.

S　　　　　If there is no point at midpoint, then determine the line on which to place the midpoint. It is acceptable to calculate the midpoint between the controlling corners (1 and 2 in Figure C-1), then going cardinal from there to the boundary line.
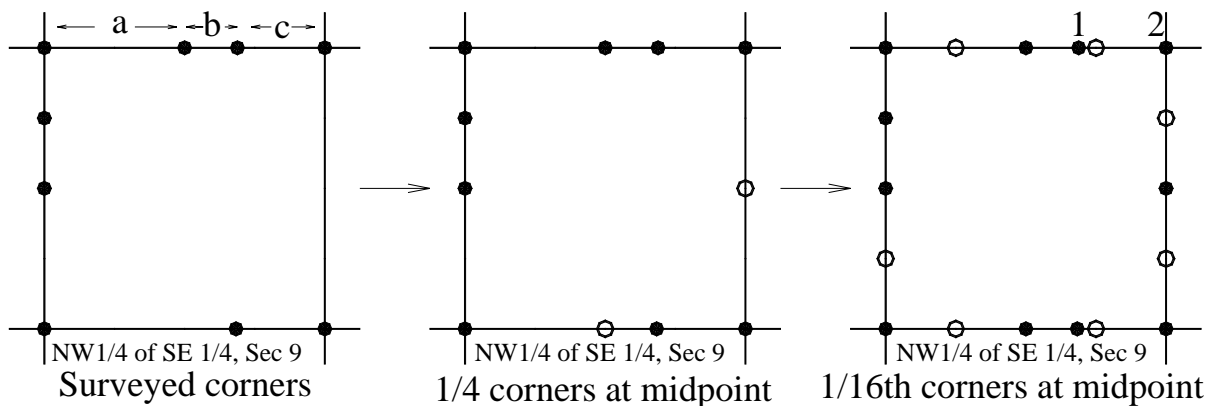

Figure C-1, unknown midpoints are computed in stages.

Very important note about latitudinal lines vs. straight lines.

Section lines and special survey boundaries have a different geometric properties than interior subdivision of section lines.

Section lines and other large surveyed features are lines of constant geographic bearing. A due west section line follows the latitudinal curve so calculating midpoints along those lines require non-planar geometry.

Interior subdivision lines, those created by intersection, are straight as in "line-of-sight" and normal algorithms for plane coordinate geometry can be applied. There are some states that direct their surveyors to use the latitudinal lines in their section subdivision. There is a data element in each entry in the ADD file that tracks whether a line is geodetic or plane so that it is clear which algorithm to use. See Appendix B - GMM File Formats, ADD File.

In minor subdivision the difference between plane and geodetic midpoints is negligible. The difference for a 1/64th corner is 0.08 inches in Arizona and 0.14 inches in Montana. For the purposes of this data using plane geometry for calculations is sufficient. It is important when testing for the existence of a midpoint to allow a tolerance in a N-S direction to find midpoints that were put on the geodetic line.

After calculating midpoint, store the midpoint parameters in ADD file. If any of the controlling corners are listed in the ADD file, determine if the line that the midpoint is on is geodetic or plane and use that code as part of the definition of the midpoint procedure. Find both occurrences of the parent line in the IID file and insert the midpoint ID between the endpoint line's ID.

Intersections: Once the midpoints have been determined on all sides of the "parent" aliquot parcel, then the direction (slope) of the centerlines can be determined. Calculate the intersection of the two centerlines. Create a point ID based on point ID rules. Store the parameters of the intersection in the ADD file. Hint: method code is "2" and the geodetic/plane code is "1" (planar). Determine the point ID strings that form the boundary of each of the newly-formed child polygons. Calculate the coordinates of the centroid for each newly-formed child polygon.

Case a - Parent aliquot is one polygon: In the IID file and GLD file, replace the entry for the parent aliquot parcel with four child aliquot parcels, including the new acreages.

Case b - Parent aliquot is two polygons, the N&S 1/2s or the E&W 1/2s: In the IID file and GLD file, replace the two entries for the two polygons with the four child aliquot parcels. Remove any "add-a-line" entry in the ADD file for the line defining the boundaries between the two parent polygons. Hint: method code is "3".
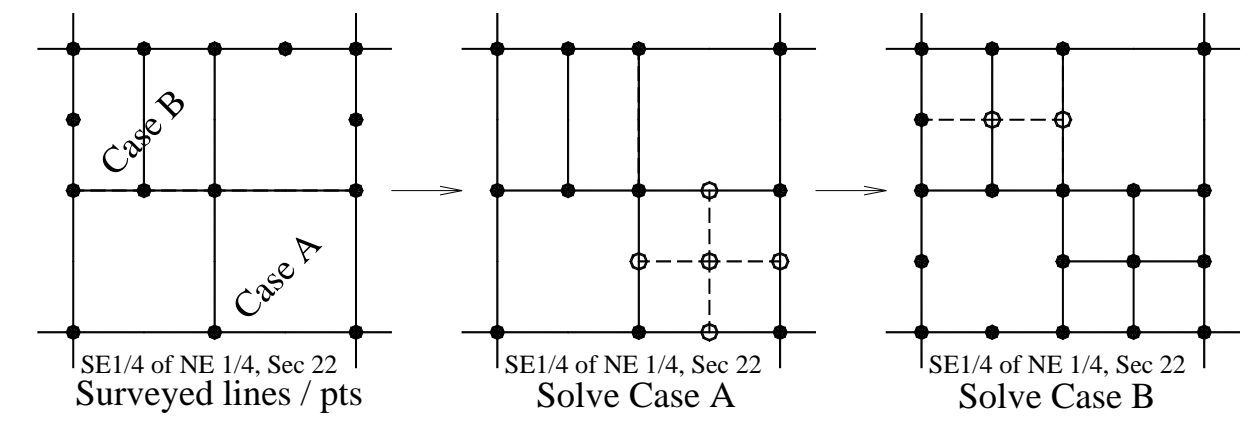

Figure C-2, solving intersections in stages

Add a line: Once the midpoints have been determined at opposite sides of the polygon, add a line between the two midpoints (controlling corners). An entry is made to the ADD file with a method code of "3" and a geodetic/plane code of "0". Determine the point ID strings that form the boundary of each of the newly formed child polygons. Calculate the coordinates of the centroid for each newly formed child polygon. In the IID and GLD file, replace the entry of the parent polygon with an entry each for the two child polygons, including the new acreages.

How GMM subdivision program APROPW.EXE treats data in the ADD file:

APROPW strips all data constructed through the section subdivision process leaving only lines and points that were entered as measurements on survey plat data. Measured lines found in the NOT file are removed from consideration. APROPW reads through the ADD file and creates any points possible, then iterates this step creating points whose parameters were created in earlier iterations. APROPW will ignore instructions to create a point if the coordinates of that point are already known. APROPW will create coordinates using plane or geodetic methods based on the plane/geodetic parameter and will calculate the positional reliabilities based on the positional reliabilities of the points used in construction. APROPW tracks line connectivity, replacing parent lines with child lines. Other subdivision processes take place using implicit rules and using data from the IRR file. The iterative processing of the ADD file occurs again. Intersections of lines that have no intersect points are created automatically. Any remaining lines in the NOT file are removed from consideration. Coordinate values are stored in several file formats, PGC, COR and GEO. All remaining line sequences are stored in the LXN file. Polygons are formed with these remaining lines and stored in the INT file. An additional executable called GETLXW stores coordinate and line data into the LX file.

How GMM attribute software LLDW and VERIIDW treats GLD data.

Presently GMM software does not read the GLD file. There is a separate program AN2GLD.EXE that converts AN files to GLD format, but minor subdivision codes are not yet supported. The IID file has a segment for each attribute and in that segment is a line in the format of the AN file. Future plans are to replace that line with a line in the format of the GLD file. Until that time the minor subdivision entries will be written to the IID file as a comment line.